

1 Fig. 5 shows another embodiment of the
2 reaction apparatus.

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4 **DETAILED DESCRIPTION**

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6 The catalytic reaction apparatus seen in Fig.
7 1 depicts a preferred embodiment of the present
8 invention. The apparatus comprises a combustion
9 chamber 4, a convection chamber 17 extending into
10 chamber 4, and a reaction chamber 16. The combustion
11 chamber 4 is defined by the zone enclosed or surrounded
12 by refractory insulation 6. The reaction chamber 16 is
13 defined by the volume enclosed by tubular reactor
14 conduit 1. The tubular reactor conduit 1 is formed in
15 a U-tube or hairpin configuration having parallel
16 upright legs 1a and 1b, and a U-shaped bend 1c, and can
17 be removed from the combustion chamber upon removal of
18 a top flange 18. Leg 1b of the tubular reactor conduit
19 1 passes concentrically through the convection chamber
20 17 defined by the space enclosed between the convection
21 conduit 10 and the leg 1b of the tubular reactor
22 conduit 1. The reaction chamber including 1a, 1b, and
23 1c is packed with catalyst from the inlet fitting or
24 means 2, where reactants enter, to the outlet port or

1 means 3 where products exit. Convection conduit opens
2 at 13 to chamber 4, and discharges at 11.

3 An axially extending, vertically disposed
4 radiant burner 7 is supported by a burner gas conduit
5 12 that conveys a mixture of fuel and oxidant from an
6 inlet means 8 to the radiant burner. In this
7 embodiment, the radiant burner 7 comprises a gas
8 permeable metal fiber zone 14 and a non-permeable zone
9 16. Fuel and oxidant pass through the permeable metal
10 fiber zone 14 where they are ignited on the surface
11 thereby combusting and releasing heat to form an
12 incandescent zone that radiates energy outward in an
13 arc 15. The arc angles γ_1 and γ_2 of 14 and 16 are
14 such (angle of 14 is between 45° and 180°) that the
15 radiating pattern maximizes the flux of radiant energy
16 to the surfaces of the tubular reactor legs 1a and 1b,
17 and also U-bend 1c, while minimizing the flux of
18 radiant energy to the internal wall 19 of combustion
19 chamber 4. Fuel and oxidant are initially ignited on
20 the surface of the permeable metal fiber zone 14 using
21 an igniter 9. Once ignited, the combustion reaction on
22 the surface of the metal fiber zone 14 facing 1a and 1b
23 is self-sustaining.

24 The radiant arc angle of 14 is selected so
25 that the direct radiant flux from the burner that
26 bisects the projected surface of the reaction chamber

1 tube wall is a minimum of 50% of the total radiation
2 flux that emanates from the active radiant burner
3 surface. As an illustration of the condition, Fig. 2
4 depicts a geometric representation of the preferred
5 embodiment of the present invention. The active
6 radiant zone 14 emits radiation along a line of sight
7 defined by a radiant arc 15 that impinges on the
8 reaction chamber conduit legs 1a and 1b and the inner
9 surface 19 of the combustion chamber. The emitted
10 radiation is bisected by hypothetical plane 50 passing
11 through the centerline of the U-tube reaction chamber.
12 The projected area of the reaction chamber surfaces per
13 unit tube length receiving direct radiation from the
14 burner within the controlled radiant arc is given by
15 $a + a = 2a$, where 'a' is the outer diameter of each
16 leg. The total radiation within the arc 15 is given by
17 $c + c + a + a + b = 2c + 2a + b$. The dimensions 'a',
18 'b' and 'c' are as shown. In the preferred
19 embodiment of the present invention, the ratio of 2a
20 divided by $2c + 2a + b$ is typically greater than 0.5 or
21 50%.

22 In the present invention, the radiant burner
23 combustion intensity is controlled in the range of
24 150,000 btu/ft²/h and 350,000 btu/ft²/h wherein the
25 combustion intensity is defined as the higher heating
26 value of the fuel combusted divided by the permeable